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Shipping and Ripening Tests with Texas Tomatoes, June 1951

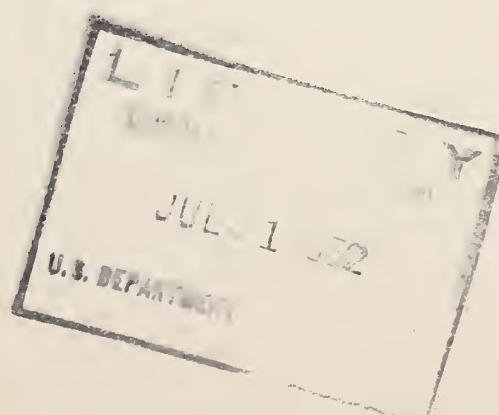
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Division of Handling, Transportation, and Storage
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Shipping and Ripening Tests with Texas Tomatoes, June 1951

OBJECT

Additional shipping tests were continued in June 1951 to determine the icing service best adapted for mature-green Texas tomatoes loaded warm. A temperature range of 55 to 60°F. is most desirable for tomatoes during transit. This temperature range affords good protection against fruit rot organisms and shortens the time required for the tomatoes to ripen after reaching the receiver. Savings in refrigeration costs would also be effected by the use of a modified icing service capable of providing moderate temperatures.

Low transit temperatures may result in chilling injury which is indicated by a high percentage of fruits which fail to ripen and an increase in the development of certain low-temperature rots. However, prompt removal of the field heat from the load is necessary to insure protection against bacterial soft rot and other high-temperature rots.

The results from an earlier test revealed that upper half stage icing, with fan services, under standard refrigeration to Jersey City gave temperatures comparable to full bunker icing. Both of these services provided over-refrigeration for tomatoes. Because the desired moderate transit temperatures were not obtained by the use of upper half stage icing, it was decided to compare the temperatures obtained in cars having initial and one reicing (Rule 247) with ventilation and those having standard refrigeration with ventilation service in the 1951 tests.

PROCEDURE

Four test cars were shipped from Hallettsville, Texas in early June in pairs with a 10 day period between the first pair (1 and 2), and the second pair (3 and 4). Time did not permit the selection of refrigerator cars in the same series but all were Preco fan cars in good condition. Three of the cars were loaded with 700 and one with 715 standard lugs of mature-green tomatoes. The fruits were Rutgers, mostly 6X6 size, and were wrapped and place-packed in lugs.

In accordance with arrangements made with the cooperator test lugs included in each car were recovered at unloading and held at the Market Pathology Laboratory in New York City for observations on ripening and decay development. Two test lugs were placed in comparable positions in each of two locations in the four cars, namely, (1) bottom layer next to bulkhead; (2) top layer at doorway. All test lugs were along the centerline of the car. These two locations were selected as representative of the coldest and the warmest part of the load during transit. A Ryan recording thermometer was placed in one test lug in each location. Loading of the four cars was completed on three different days at two packingsheds. Loading conditions however were very similar. Maximum fruit and air temperatures of 92°F. were observed but the average fruit temperature was 88 to 89°.

The four cars moved by the same routing i.e., Texas and New Orleans to Corsicana; Cotton Belt to E. St. Louis; Pennsylvania R.R. to Jersey City. Fans were sealed in the desired "off" or "on" position before departure from Hallettsville. The nearest icing facilities were located at Hearne where cars 1 (PFE-66655) and 2 (PFE-6430) serviced according to Rule 247 received their initial icing 16 and 12 hours respectively after loading had been completed. Ventilators were opened during this part of the trip. Cars 3 (PFE-47012) and 4 (PFE-5328) were pre-iced in Victoria approximately 28 hours prior to the completion of loading.

The icing and ventilation service for each car as well as the amount of ice supplied and the time at each icing point are given in table 1.

Tomatoes from the test cars were handled separately at the prepackaging plant so that the effect of transit temperatures on the rate of ripening could be determined together with other detailed studies made under commercial conditions on a car-load basis. All lugs in the test cars were marked so they could be identified throughout the ripening process.

The tomatoes were separated into 4 categories at the time of the initial sorting. These were composed of; (1) tomatoes ripe enough to prepackage; (2) those showing only a trace of color (light turns); (3) those showing no color, but a paling of the green color (dark turns); and (4) those showing no changes in shade of green color (greens). Each of the latter three categories were handled separately in subsequent sortings. The tomatoes were ripened in partially filled lug boxes stacked on pallets. The ripening rooms were maintained at 62° F. and 80 to 85 percent relative humidity.

RESULTS

Temperature in transit

Recording of outside air temperatures during the transit periods were not obtained. However, an examination of U.S. Weather Bureau daily temperature records for eight transit-point cities revealed considerable differences in the prevailing air temperatures during the periods involved. Cars 1 and 2, (Rule 247), experienced above-normal temperatures to Pine Bluff, Arkansas and Pittsburgh, Pa., respectively. The greatest departure from normal temperature was plus 14 degrees encountered at Columbus, Ohio by car 2. The other two test cars, (standard refrigeration to Columbus), were enroute during a period of nearly normal average temperatures to Pittsburgh with below-normal temperatures at points further east. It should be noted that the two cars which received the least ice (Rule 247) were in transit during periods in which above-normal average temperatures occurred at some points while the two cars under standard refrigeration were moved during a period of normal and below-normal temperatures.

The transit temperatures recorded in the test lugs located at the bottom bulkhead and top doorway positions in each car are shown in figures 1 to 4 inclusive.

In car 1 (PFE-66655) moving under Rule 247 with fan service and diagonal vents open from Pine Bluff, Arkansas to destination fruit temperatures were reduced to 70°F. in the bottom bulkhead and the top doorway test lugs within 27 and 36 hours respectively after loading was completed. A considerable portion of this elapsed time resulted from the 16 hours delay before the initial icing at Hearne. After the load cooled to 70°, a satisfactory range of temperatures was maintained during transit. The top doorway position averaged about 66° and the bottom bulkhead positions averaged about 60.5° (Fig. 1). At the time of unloading the temperature of tomatoes ranged from 64° in the coldest and 71° in the warmest locations in the car.

In car 2 (PFE-6430), moving under Rule 247 without fan service and with diagonal vents open from Pine Bluff, Arkansas to destination fruit temperatures in the bottom bulkhead lugs dropped to 70°F. in 27 hours, the same time as in comparable lugs in car (1). Fruits in this position cooled fairly rapidly from 70° to 50° and then the temperature rose to 68° in about 38 hours. It then dropped slightly to 66° for a few hours and gradually leveled off to 68° (Fig. 2). In the top doorway location however, fruit temperatures never fell lower than 73° and averaged 74 to 75° for the greater part of the transit period.

Fruit temperatures at the time of unloading ranged from 67° in the bottom bulkhead position to 75° in the top doorway position. The wide spread between the minimum and maximum temperatures in the car and the relatively high temperatures recorded in the top doorway lugs can be attributed to two factors, (1) lack of fan service to equalize the air temperature; and (2) ventilation during a period in which above-normal average temperatures prevailed outside.

Although originally billed to move under different icing and ventilation services car 3 (PFE-47012) and car 4 (PFE-5328) actually received the same services, namely, pre-iced, fan service, standard refrigeration to Columbus, diagonal vents opened from there to destination. Fruit temperatures in the bottom bulkhead location in both cars dropped to 70°F. within 6 hours after loading was completed. In the top doorway position fruit temperatures in the two cars dropped to 70° in 33 and 30 hours. Minimum temperatures reached in the bottom bulkhead location in the two test cars were lower than desired (Fig. 3 and 4). The recorded temperatures in the two cars after the fourth reicing at Indianapolis were 42 and 46° in the bottom bulkhead location and 58 and 53° in the top doorway respectively. At unloading, fruit temperatures in car 3 (PFE-47012) varied from 50 to 65°. In car 4 (PFE-5328) fruit temperatures ranged from 55° to 61°. This narrow range of fruit temperatures in car 4 reflected a better car performance under partial ventilation by having only one fan in operation. Apparently the fan in B-end was cut off at Columbus where diagonal vents were opened.

COMMERCIAL HANDLING OF TOMATOES

At Prepackaging Plant

The four test cars were unloaded within a day after arrival at the terminal market prepackaging plant. Unless a car arrives with sufficient fruits ripe enough to prepackage, the load is ordinarily held in the packing plant for a few days before making the initial sort. The tomatoes from car 1 were held on the warehouse floor at a temperature of 70° to 82°F. for 4 days before they were sorted. At the initial sort 56.8 percent of the fruits were ripe enough for prepackaging. Car load 2 which had higher pulp temperatures and more fruits in the turning stage on arrival than any of the 4 cars, was sorted after standing 1 day on the warehouse floor at 74° to 77°F. At the initial sort 34.4 percent of the fruits were ripe enough for prepackaging. Tomatoes in cars 3 and 4 arrived with 98 to 99 percent of the fruits green and were held in a regular ripening room at 62° for 6 days before they were sorted. At the initial sort 43 percent of the tomatoes in car 3 and 30.2 percent in car 4 were ripe enough for prepackaging.

Table 2 shows the percentage of tomatoes ripe enough for prepackaging after different periods of time. Cars 3 and 4 were handled identically after arrival and can be compared with each other, but comparisons of the other cars cannot be made.

Car 1 (PFE-66655) moved under modified icing service and the tomatoes were held on the warehouse floor at 70° to 82°F. for 4 days before the initial sort. Moderate ripening temperatures during transit together with the 4 days of forced ripening stated above resulted in 56.8 percent of the fruits ripe enough for prepackaging at the initial sort. The rate of ripening was slowed down by holding the fruits to be ripened at 62° after the initial sort. Fourteen days were required to complete the ripening. A total of 93.3 percent of the ripened fruits were prepackaged and there was 6.7 percent waste (Table 2).

Car 2 (PFE-6403) moved under modified icing service and the tomatoes were held on the warehouse floor at 74° to 77°F. for 1 day before the initial sort. Lack of fan service in car 2 caused a wide spread in temperatures between the top and bottom layers until the ice was melted. Fruits in the top doorway did not cool below 74°F. for most of the transit period. These temperatures stimulated ripening in general. Although the tomatoes were held on the warehouse floor for only 1 day before sorting and then ripened at 62°, 91.4 percent of the fruits were ripe enough for prepackaging 7 days after arrival. Ripening was completed on the 12th day after arrival. A total of 95.9 percent of the fruits in the car were prepackaged and there was 4.4 percent waste (Table 2).

Cars 3 and 4 were shipped with fans on standard refrigeration to Columbus, Ohio diagonal vents open to destination. The tomatoes from both cars were placed immediately in the ripening room at 62°F. when unloaded. The lower transit temperatures together with ripening at 62° resulted in a moderate rate of ripening. Tomatoes from car 3 were about 95 percent ripe on the 14th day after unloading while those in car 4 were about 92 percent ripe for prepackaging. The greenest fruit in both cars required 18 days to complete ripening. A total of 95.9 percent of the fruits in car 3 were prepackaged and the waste was 4.1 percent. In car 4 there was 94.1 percent prepackaged and the waste was 5.9 percent (Table 2).

Tomatoes unfit for packaging in the 4 test cars varied from 4.1 to 6.7 and averaged 5.3 percent (Table 3). Fruits too ripe for prepackaging, together with some that were bruised, puffy or slightly blemished averaged 1.1 percent. Such fruits known as "soups" by the trade were sold at a reduced price. Mechanical injury such as shoulder scars, cuts, punctures, crushed fruits, box rubbing, and pressure bruising caused most of the waste. In 3 of the 4 cars, shoulder scars caused more waste than decay. Much mechanical injury could be avoided by improved methods of handling and packing. Liners and top and bottom pads in lug boxes would probably furnish greater protection against mechanical injury in transit than the tissue wraps now in use. Decay was slight in all cars, averaging 0.75 percent for the 4 test cars. The warmest car on arrival (PFE-6430) had the most decay, which was mostly bacterial soft rot and watery rot.

An examination of 2,400 tomatoes being prepackaged showed that 83 percent had over 50 percent pink color. Only 7 percent were prepackaged in the slight turning stage having less than 25 percent of the surface pink.

TOMATOES IN TEST LUGS

In table 4 are given the results of the arrival inspection and data on ripening of the tomatoes in the test lugs from each car. The only firm ripe fruits at the time of unloading were found in the top doorway location in the two cars moved under Rule 247. Considerable differences are apparent in the percentages of fruits from the two test positions in the four cars which had not ripened after being held for 12 and 14 days under optimum conditions. These differences are particularly evident in cars 3 and 4, standard refrigeration, where over 12 percent of the bottom bulkhead fruit remained green in comparison with 2.9 and 1.9 percent respectively of the fruit in the top doorway. Tomatoes from the top doorway or warmest position ripened faster in all cars than those from the coldest position at the bottom bulkhead.

Discussion of Transit Temperatures

An examination of the icing record and temperature charts will show that in car 1 (PFE-66655) the desired moderate transit temperatures were obtained by using the modified icing service available under Rule 247 with fans operating and diagonal vents open from Pine Bluff, Arkansas to destination. One evident weakness was the initial lag of 16 hours before any heat was removed from the load because of the delayed initial icing. The use of pre-iced cars would correct this weakness.

It is obvious that the modified icing service in car 2 (PFE-6430) without benefit of fan service failed to provide desirable temperatures.

Cars 3 (PFE-47012) and 4 (PFE-5328) were pre-iced, had fan service, standard refrigeration to Columbus, Ohio then diagonal vents open to destination. The temperatures as indicated in figures 3 and 4 show that this service provided over refrigeration resulting in undesirably low temperatures in the bottom layers of the cars. Not only was the service more costly in using approximately \$30.00 worth of unnecessary ice, but the tomatoes ripened slower in the pre-packaging plant, thus requiring more handling and sorting.

SUMMARY

Tests were made on four cars of mature-green tomatoes shipped from Hallettsville, Texas to Jersey City, New Jersey in June 1951.

Arrival in Jersey City was on the sixth morning after leaving Hallettsville.

Ryan thermometers recorded the temperatures in the bottom bulkhead (coldest) position and top doorway (warmest) position in each car.

Data were obtained on the rate of ripening and the extent of decay and other types of waste both on test packages and on the entire car in the commercial repacking plant.

Car 1 (PFE-66655) fans operating, initially iced, and reiced once at Pine Bluff, Arkansas where diagonal vents were opened was the only car that provided a desirable temperature range (between 55° and 65°F.).

Car 2 (PFE-6430) had the same service as car 1, except that fans were not operated. This service failed to cool the top layers of the load to desirable temperatures.

Cars 3 (PFE-47012) and 4 (PFE-5328) were pre-iced, standard refrigeration to Columbus, Ohio, diagonal vents open beyond Columbus, fans operated. This service provided excessive refrigeration.

From 12 to 18 days were required to ripen the tomatoes after unloading from the different cars. Because the tomatoes from cars 1 and 2 were ripened at different temperatures from those in cars 3 and 4, a comparison of rate of ripening between cars moved under different service cannot be made.

A high percentage (93.2 to 95.8) of tomatoes from all cars were suitable for prepackaging.

Total waste varied from 4.1 to 6.7 percent; only 0.6 to 1.2 percent of this was due to decay. Shoulder scars, box rubs, cuts, and punctures, were the principal causes of waste in the tests.

Examination of the ripeness of tomatoes being prepackaged showed that 83 percent had over 50 percent of pink color.

Table 1. Icing Record for Test Cars 1/

Car (1) PFE-66655 Rule 247: with fan service
Diagonal vents opened at Pine Bluff, Ark.

Initial icing	Hearne	June 2	10:15 a.m.	11,500 lbs.
1st reicing	Pine Bluff	June 3	11:20 a.m.	9,000 lbs.
			Total	<u>20,500 lbs.</u>

Ice left in bunker upon arrival: none

Car (2) PFE-6430 Rule 247: without fan service
Diagonal vents opened at Pine Bluff, Ark.

Initial icing	Hearne	June 1	8:15 a.m.	11,500 lbs.
1st reicing	Pine Bluff	June 2	8:35 a.m.	6,000 lbs.
			Total	<u>17,500 lbs.</u>

Ice left in bunker upon arrival: none

Car (3) PFE-47012 Pre-iced, standard refrigeration to Columbus,
diagonal vents opened at Columbus. Fan service.

Initial icing	Victoria	June 8	3:00 p.m.	11,500 lbs.
1st reicing	Hearne	June 10	8:10 a.m.	6,000 lbs.
2nd reicing	Pine Bluff	June 11	5:15 a.m.	7,000 lbs.
3rd reicing	E. St. Louis	June 11	8:15 p.m.	3,000 lbs.
4th reicing	Indianapolis	June 12	11:55 a.m.	1,800 lbs.
			Total	<u>29,300 lbs.</u>

Ice left in bunker upon arrival: 600 lbs. in B-end only.

Car (4) PFE-5328 Pre-iced, same icing and ventilation
service as car (3). (Only one fan on upon arrival)

Initial icing	Victoria	June 8	3:00 p.m.	11,500 lbs.
1st reicing	Hearne	June 10	8:10 a.m.	6,000 lbs.
2nd reicing	Pine Bluff	June 11	5:40 a.m.	7,000 lbs.
3rd reicing	E. St. Louis	June 11	8:00 p.m.	1,800 lbs.
4th reicing	Indianapolis	June 12	11:55 a.m.	4,600 lbs.
			Total	<u>30,900 lbs.</u>

Ice left in bunker upon arrival: 600 lbs. in B-end only.

1/ Icing records on test cars were made available by:
Pacific Fruit Express Company - Edinburg, Texas.
St. Louis Southwestern Railway Lines - Tyler, Texas.
Fruit Growers Express Company - Washington, D. C.

Table 2. Rate of Ripening of 4 Cars of Texas Tomatoes in a Commercial Repacking Plant

	Car 1, PFE-66655 Rule 247, Fans on Shipped June 1 Arrived June 7	Car 2, PFE-6430 Rule 247, Fans off Shipped May 31 Arrived June 6	Car 3, PFE-47012 Std. Rfr. Fans on Shipped June 9 Arrived June 15	Car 4, PFE-5328 Std. Rfr. Fans off Shipped June 9 Arrived June 15
Days After Arrival			Percentage of Tomatoes Ripe for Prepackaging After Each Sorting (Cumulative)	
2		34.4		
5	56.8	50.6		
6			43.0	30.2
7	71.0	91.4	55.0	46.7
8	81.5		63.1	60.9
9		95.0		
10			63.7	61.7
12	92.9	95.6	89.1	
13				90.8
14	93.3		95.1	92.0
18			95.9	94.1
Total Percentage Ripened and Usable	93.3	95.6	95.9	94.1
Total Waste (decay, blemishes, overripe)	6.7	4.4	4.1	5.9
	100.0	100.0	100.0	100.0

Table 3. Types and Amount of Blemishes and Decay Causing Waste in Ripening and Repacking 4 Cars of Texas Tomatoes in a Commercial Plant
(Expressed as Percentage of Total Fruit)

Type Blemish or Decay	Percentage of Waste During Ripening		
	At Initial Sort	At Later Sortings	Total Waste
Blossom end rot	0.10	0.02	0.12
Shoulder scar	0.41	0.55	0.96
Box rubs	0.42	0.19	0.61
Pressure bruises	0.19	0.12	0.31
Cuts, punctures	0.27	0.26	0.53
Growth cracks	0.12	0.06	0.18
Worms, insects	0.16	0.06	0.22
Crushed fruit	0.08	0.02	0.10
Shriveling	0.01	0.04	0.05
Immature	0.04	0.10	0.14
Field scars	0.04	0.02	0.06
Sun scald	0.06	0.01	0.07
Scuffing	0.06	0.02	0.08
Miss shaped	0.01	0.01	0.02
Bacterial soft rot	0.31	0.06	0.37
Alternaria rot	0.07	0.03	0.10
Phoma rot	0.06	0.02	0.08
Rhizopus rot	0.01	0.02	0.03
Watery rot	0.10	0.01	0.11
Virus diseases	0.04	0.02	0.06
Overripe, soft (soups)*	0.83	0.21	1.10
Total Waste from Blemishes			3.45
Total Waste from Decay			0.75
Total Waste from Overripeness			1.10
Total Waste	3.39	1.91	5.30

* The overripe and soft fruits are not prepackaged but are sold at a mark-down. Therefore they are not a complete loss. Known as "Soups" to the trade, they include some blemished and some puffy fruits as well as those too soft to prepackage.

Table 4. Arrival Condition and Ripening Date of Tomatoes in Test Lugs

Car No.	Color Upon Arrival***						Firm Ripe at Each Inspection (Cumulative)						Remaining Unripe on 14th Day Deeay		
	Total Fruit Position	Green %	Slight Turning Medium	Firm Turning Advanced	Firm Ripe %	0 days %	4 days %	7 days %	8 days %	10 days %	12 days %	14 days %			
Car (1)* PFE-66655 Rule 247 Fan Service	TD 200	76.5	8.0	2.5	6.0	7.0	7.0	28.5	-	77.0	-	97.0	-	1.0	2.0
BB 202	93.5	4.0	2.5	0	0	0	7.4	-	59.9	-	91.6	-	6.4	2.0	
Car Total	402	85.0	6.0	2.5	3.0	3.5	3.5	17.9	-	68.4	-	94.3	-	3.7	2.0
Car (2)** PFE-6430 Rule 247 No Fan Service	TD 200	73.0	9.5	6.0	4.5	7.0	7.0	62.0	-	96.0	-	100	-	0	0
BB 203	97.5	0.5	0.5	1.5	0	0	9.9	-	57.7	-	92.7	-	7.3	0	
Car Total	403	85.3	5.0	3.2	3.0	3.5	3.5	35.8	-	76.7	-	96.3	-	3.7	0
Car (3)*** PFE-47012 Std. Refrig. to Columbus Fan Service	TD 207	98.1	1.0	0.4	0	0	0	2.4	16.9	-	59.9	-	96.1	2.9	1.0
BB 205	100	0	0	0	0	0	0	0	4.9	-	29.3	-	86.3	12.7	1.0
Car Total	412	99.0	0.5	0.2	0	0	0	1.2	10.9	-	44.7	-	91.3	7.7	1.0
Car (4)**** PFE-5328 Std. Refrig. to Columbus Fan Service (One fan off)	TD 215	98.1	1.4	0.5	0	0	0	4.2	19.5	-	67.4	-	98.1	1.9	0
BB 206	98.5	1.0	0.5	0	0	0	1.9	6.3	-	30.6	-	87.4	12.6	0	
Car Total	421	98.3	1.2	0.5	0	0	0	3.1	13.1	-	49.4	-	92.9	7.1	0

* Diagonal vents opened at Pine Bluff, Arkansas, to destination.

** Diagonal vents opened at Columbus, Ohio, to destination.

*** Slight turning 0-25% pink color, Medium turning 26-50% pink, Advanced turning 51-75% pink,
Firm Ripe 76-100%, pink.

Fig. 1. Tomato Shipping Test - Hallettsville, Texas to Jersey City, June 1951

Car No. 1

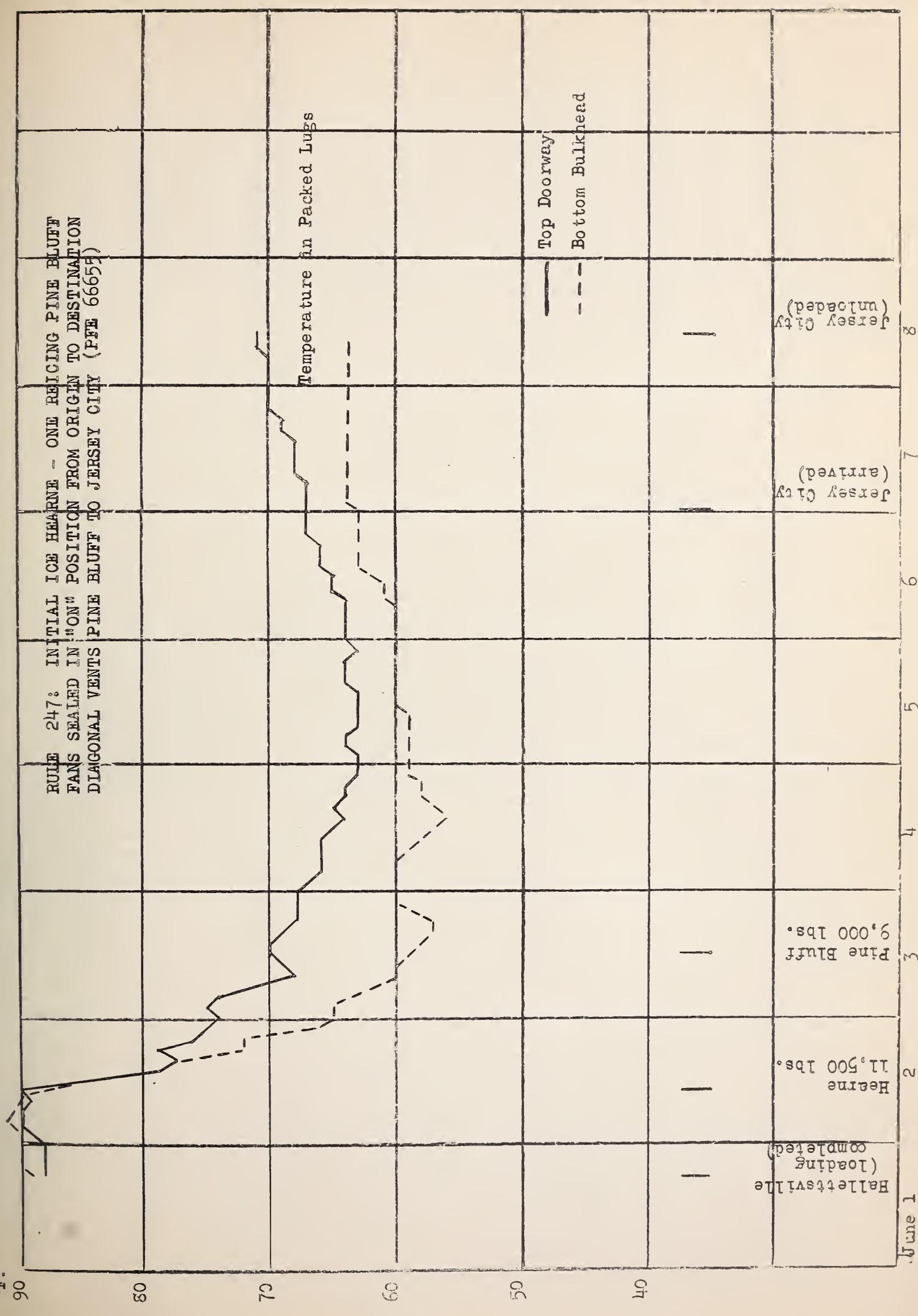


Fig. 2 Tomato Shipping Test - Hallettsville, Texas, to Jersey City, June 1951

Car No. 2

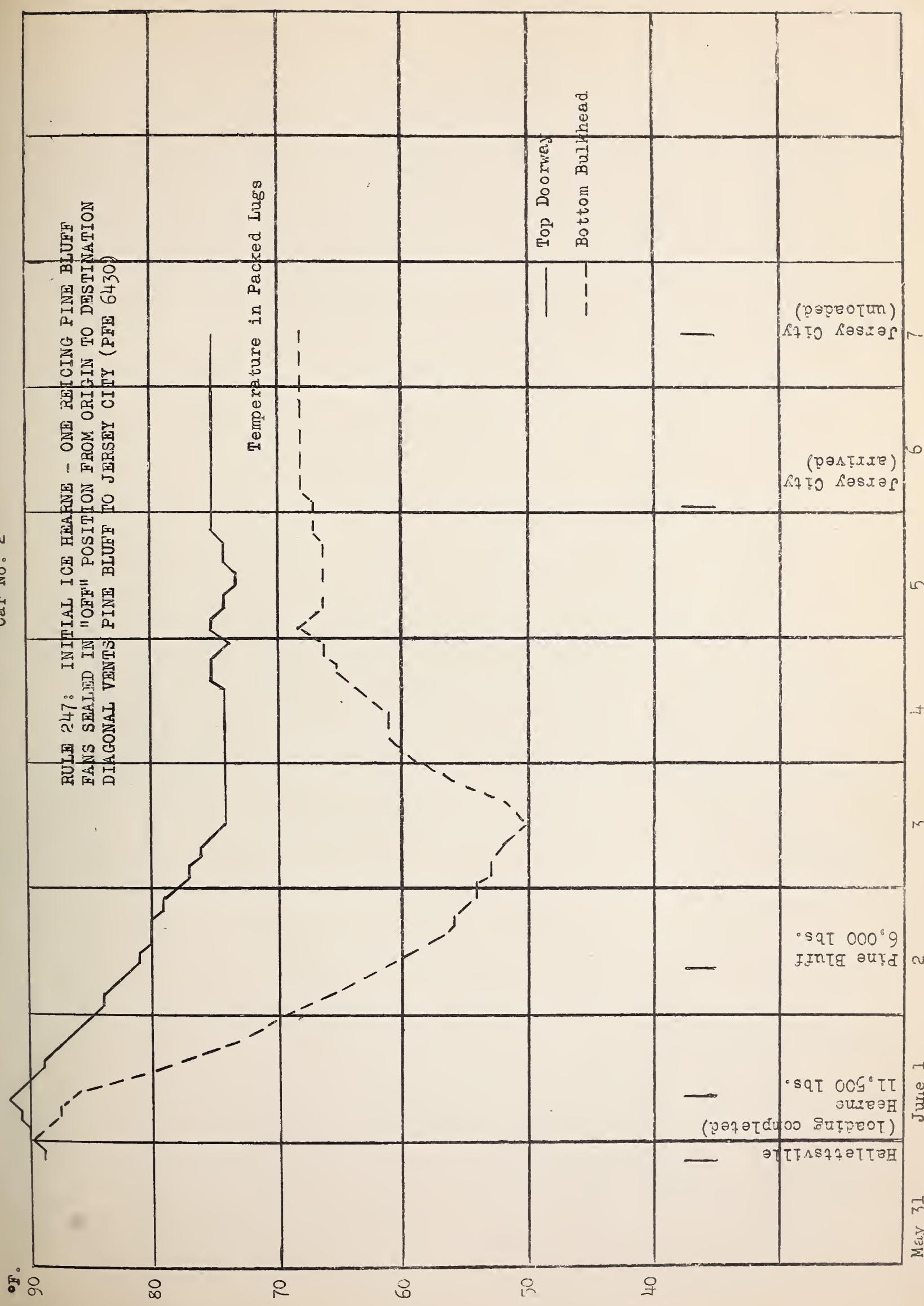


Fig. 3 Tomato Shipping Test - Hallettsville, Texas to Jersey City, June 1951

Car No. 3

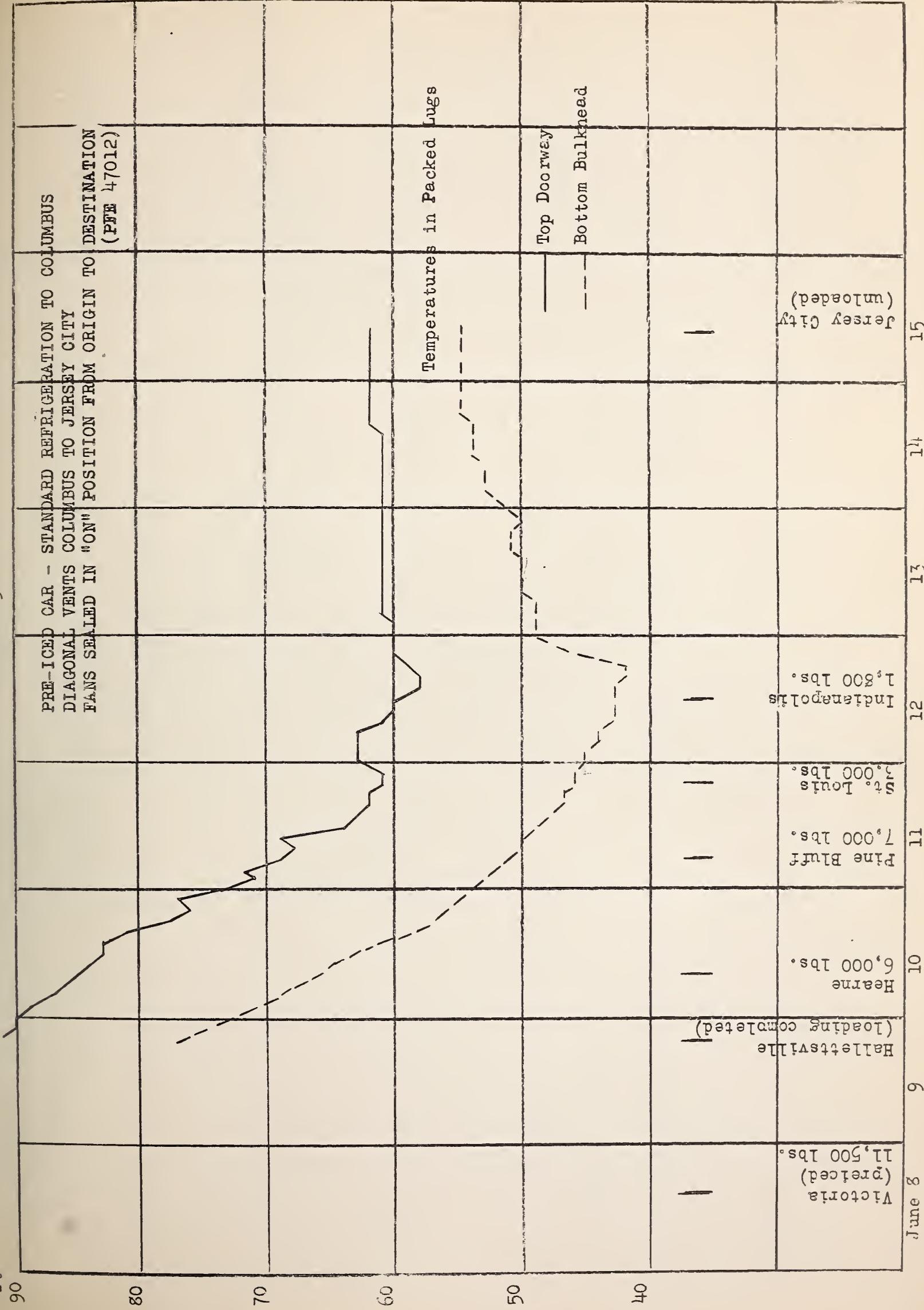


Fig. 4 Tomato Shipping Test - Hallettsville, Texas to Jersey City, June 1951

Car No. 4

